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Reviews

Assistive Technology: Use and Service Delivery

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As individuals with long-term disabilities and other older adults face declines in health and function, there is a greater need for assistive technology (AT) or assistive devices and environmental interventions (EI) to help them maintain their independence and community participation. These aids can help older adults and individuals with disabilities function in work, home, recreational, and other community settings as they encounter age related or disability related changes. 'Assistive Technology refers to products, devices or equipment that are used to maintain, increase or improve the functional capabilities of people with disabilities. A thorough assessment of the individual's preferences and needs must be conducted before an assistive device is obtained. If one type of device is inadequate to meet an individual's needs, it should not be assumed that there are no viable alternatives. Individuals' use of AT and the type of technology used may change over time or as they age. Low-tech aids, such as canes or walkers, or high-tech aids, such as manual or power wheelchairs or scooters, are used to help individuals achieve mobility. Assistive Technologies to aid in communication currently range from low-tech devices such as books to high-tech, augmentative communication devices, which are computers. Computer technology can help individuals become more independent and can enhance their ability to overcome a wide range of limitations. Accessibility can involve more than architectural structure. AT for use in the environment can also increase individuals' ability to function within their environment. Advancements in AT will occur in the technology itself, the services associated with the technology, and in the government policies and programs relative to AT. There will more widespread use of universal design, with less special-purpose AT required.

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Introduction

As individuals with long-term disabilities and other older adults face declines in health and function, there is a greater need for assistive technology (AT) or assistive devices and environmental interventions (EI) to help them maintain their independence and community participation. With earlier discharge from hospitals and greater emphasis on community living, there is a greater need for AT/EI approaches to help the older adult and the family caregiver. New and highly personalized devices and technological advances can now aid aging individuals with disabilities in maintaining or increasing their independence, productivity, and quality of life. AT/EI innovations reduce their dependencies on others for assistance, lower their risk of secondary conditions, allow caregivers to provide assistance more easily, and forestall the need for nursing home care. Advances in microelectronics, computer science, communications, bioengineering, and health and rehabilitation sciences have led to the development of a host of physical and cognitive aids. These aids can help older adults and individuals with disabilities function in work, home, recreational, and other community settings as they encounter age related or disability related changes. Examples of the uses of such technologies include the following:

- Helping with planning, execution, attention, and memory (cognitive prosthetics and orthotics)
- Monitoring health and safety (tele-care, tele-health, alert systems)
- Assisting with ADLs and IADLs (robotics, personal digital assistants, adapted eating devices, Hand rails)

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- Controlling the physical environmental in the home (environmental controls, ramps)
- Facilitating greater community participation (navigational systems, recreational aids, communication devices for social interaction)
- Improving mobility (wheelchairs)
- Providing communication and learning aids for educational and employment settings (augmentative communication devices)
- Using information technology (Internet, computers, adapted web browsers)
- Helping to improve vision (glasses) and hearing (hearing aids) [1].

What is Assistive Technology?

In the USA, the Technology-Related Assistance for Individuals with Disabilities Act 1988, the Assistive Technology Act 1998 and the Access Board's Electronics and Information and Technology Accessibility Standards all contain the following formal legal definition of 'assistive or adaptive technology': 'products, devices or equipment, whether acquired commercially, modified or customized, that are used to maintain, increase or improve the functional capabilities of individuals with disabilities' [2]. The terminology of this definition has clearly been influenced by the medical model of disability. The focus is on rehabilitation and specifying the assistive technologies that are eligible for funding rather than a wider range of applications. In the European Union, 'Assistive Technology refers to products, devices or equipment that are used to maintain, increase or improve the functional capabilities of people with disabilities. Assistive Technology can help to compensate functional limitations and enable people with disabilities to participate in the activities of daily life, including employment and training.' [3]

Who uses Assistive Technology?

While many older individuals and their caregivers could benefit from such advances, often they are unaware or unable to access or pay for them. This is particularly true for individuals with intellectual disabilities who lag behind other disability groups in their use of technology. Older people and people with disabilities are less likely than other people to own or use computer technology. Barriers to use include lack of proper equipment, poor fit of mobility devices, lack of training in use of equipment, poor communication of needs, and reluctance to accept need for devices [4]. It is worth mentioning that there is a direct relation between ageing and disability, in a way that while population gets old, the number of people with disability increases. For this reason, elderly people will represent the core of the group of people with disabilities in the coming years. On the other hand, technology is having an unstoppable evolution and penetration in all fields, becoming an essential element in people's life and, even being in some cases, a quality of life provider. However, technology is having great difficulties to penetrate the field of ageing; and elderly people are far from taking advantage from the potential benefits of technology in terms of quality of life. In this scenario, there is no other chance than activating technology as a key element to face the challenges derived from ageing. An element that, as well as being a key factor to face these challenges could even is the engine to transform this challenge into an opportunity; creating a new economy around ageing [5].

Individual Assessment

Individuals' physical as well as psychosocial environment has an impact on the usefulness of an assistive device. Consequently, the characteristics of the environment must always be considered [6,7]. Both the type and number of AT needed will vary. Few people function in only one setting. Thus, individuals with disabilities may require specific devices for activities of daily living, different devices to be used at work, and still other devices to be used in social and recreational settings. People with similar disabilities may not require the same type or the same number of assistive Technologies. The type of assistive device needed depends on where the equipment will be used, the tasks and activities required in each environment, and the extent to which tasks would be enhanced by the use of the device. Architectural accessibility and the amount of environmental support needed for the use of an assistive device also are important considerations. The physical environment in which the assistive device is to be operated must be assessed, and obstacles that could interfere with the device's use must be identified. At times, environmental modification alone may increase the individual's ability to function. As society becomes increasingly aware of the need for universal design so that environments are more accessible for all individuals, many physical barriers that exist today may be nonexistent in the future. In addition to the

physical environment, the psychosocial environment also has an impact on the usefulness of assistive Technologies. The amount of support and encouragement individuals receive from others in their environment may be a major determinant in the degree to which an assistive device is used. The cultural environment in which individuals function also plays a major role in the type of device obtained and the extent to which it is used. For example, not all individuals who are deaf or hard of hearing believe that they need to compensate for their decreased ability to hear. Many individuals who are deaf have a strong cultural identity with the Deaf community and may not be receptive to many of the technological advances that are currently available or that may become available in the future. A thorough assessment of the individual's preferences and needs must be conducted before an assistive device is obtained. If one type of device is inadequate to meet an individual's needs, it should not be assumed that there are no viable alternatives. Likewise, it should not be assumed that all individuals with the same disability require the same type of device. Although it is likely that individuals with severe disability may require high-technology devices, it should not automatically be assumed that individuals want that type of device or that other devices could not be equally useful [6,7,8].

Types of Assistive Technology

Individuals' use of AT and the type of technology used may change over time or as they age. If individuals have a progressive disability, different assistive technologies may be needed over time to accommodate additional limitations. In other instances, different devices may be required because an individual's lifestyle has changed. Human circumstances are not static. Flexibility must be maintained in evaluating the continuing and changing needs of individuals. Assistive technologies vary in complexity. Whereas some devices are relatively easy to use, others require considerable training and practice before they can be used effectively. The most effective assistive device is one that individuals are comfortable using and one that meets their own particular needs. Technological devices, especially if they are high tech, may be intimidating to some individuals. Anxiety or insecurity about the ability to use a device may cause them to avoid using it or to abandon it. The more sophisticated the device, the more complicated it may be to use [8].

Devices for Activities of Daily Living

Devices used in general activities of daily living such as grooming, eating, bathing, toileting, and dressing are generally low-tech aids, and although they usually are less expensive, they are vital to independence and to reaching goals in other areas. They can be as simple as an item purchased from a hardware store, or they can be specially manufactured to meet a specific need. The type of functional limitations and the environments in which the device is to be used determine the type of device needed for activities of daily living. Individuals' needs may change as they move to different environments. For example, devices used in the home for activities of daily living may not be appropriate on a business trip. The appropriateness of each device should be considered in the context of the setting in which it is to be used. A variety of devices used by individuals *without disability* also help to increase the functional capacity of individuals *with disability*. Devices such as microwave ovens, electric can openers, and other electronic devices may be convenience items for people without disability, but the same devices also can significantly increase the functional capacity and independence of people with disabilities. The increasing sophistication of computers, robotics, and other electronic devices may also offer more functional independence in activities of daily living for persons with disabilities in the future [9,10,11,14].

Mobility Aids

Low-tech aids, such as canes or walkers, or high-tech aids, such as manual or power wheelchairs or scooters, are used to help individuals achieve mobility. Microcomputer- controlled power wheelchairs and powered wheelchairs with puff-sip controls provide increased mobility to individuals with severe disabilities. New technological advances may provide wheelchairs that have instrumentation to alert users that they are too close to objects or that decrease power when there is an object in the path [12]. Different wheeled mobility devices may be needed for the same individuals. Some individuals may require one type of wheelchair for indoor use and another type for sports or outdoor use. Transportation is also an important mobility need, both for getting to work and for increased independence. Hand controls and steering devices to accommodate the needs of individuals with limited use of one or more extremity enable individuals to

drive standard motor vehicles. Van conversions such as wheelchair lifts enable individuals to carry wheelchairs or scooters, which can then be used at their point of destination. The sophistication of mobility and transportation devices will continue to be enhanced in the future. It is possible, however, that without public awareness, environmental constraints will still be a barrier to full adaptation. Wheeled mobility aids as well as transportation aids are only maximally effective when the environment accommodates their use. Both adaptive devices and environmental modifications are necessary for individuals to reach their full independent living and work potential [9,10,11,14].

Sensory Devices

A variety of adaptive devices are available for individuals with sensory impairments, ranging in sophistication from simple to complex. For example, an item as simple as a bath thermometer may be important to a person with sensory impairment of the lower extremities in order to prevent burns when bathing, and an optical- to-vibrotactile prosthesis can make it possible for individuals who are blind to distinguish patterns of stimulation so that they can discriminate between certain properties of three-dimensional space. AT for individuals with visual impairment may range from glasses to voice recognition computers. A variety of low-vision aids that magnify or enhance visual images may also be used. AT for individuals with deafness or who are hard of hearing may use amplification, vibrotactile prompts, or visual cues. Assistive Technologies such as hearing aids and telecommunication display devices can help individuals who are deaf or hard of hearing to function in a hearing world [9,10,11,14].

Communication Devices

Communication is a complex activity involving perception and integration of information and includes speaking, writing, reading and hearing, or signing as well as other nonverbal means of communicating. Assistive Technologies to aid in communication currently range from low-tech devices such as books to high-tech, augmentative communication devices, which are computers. Whether individuals use low technology or high-technology devices, a certain degree of cognitive and motor ability as well as training is required. Communication devices can be manual or electronic. Examples of manual devices are communication boards or other systems in which individuals spell out messages or indicate phrases to another person. Electronic systems are often computer based and may filter or manipulate vocalizations or provide synthesized speech. Because of the complexity of communication and the varying capabilities and needs of individuals in different situations, no one type of device is appropriate for everyone. The device chosen to augment or enhance communication must be one that meets the specifications of the individual who will be using it. Because communication is such an individual and personal function, the individuals using a device are the best qualified to evaluate whether it improves communication outcomes [9,10,11,14].

Cognitive Memory Aids

Memory problems, whether related to brain injury or dementia, can impair individuals' quality of life and ability to function independently. Although there are many memory improvement techniques that have been utilized to help individuals increase memory performance, improvement is often short-lived. A number of external devices or systems that serve as memory enhancements have been developed. Some assistive technologies permit the user to record and play back messages; others are used as reminders, such as voice-activated reminder calendars; both can be of help to individuals with memory problems [9,10,11,14].

Adaptive Computer Aids

Computer technology can help individuals become more independent and can enhance their ability to overcome a wide range of limitations. Some disabilities, however, make computer use difficult. For individuals with these disabilities, a number of assistive Technologies, such as head controls, can provide an alternative means to computer access. Software has also been developed that automatically adjusts to the needs of the particular individual, especially if the disability limits head or neck movement as well as movement of the upper extremities [13].

Controls and Switches

Control mechanisms or switches may be used to operate computers, communication aids, and home environmental controls [8].

Environmental Modifications

Accessibility can involve more than architectural structure. AT for use in the environment can also

increase individuals' ability to function within their environment. Simple examples are a Braille labeler to help in identifying items, or a talking smoke alarm as a warning system [8].

Assistive Technology Services

A model for assessing the component interactions of the service delivery system has been developed to provide a framework for understanding how AT and the services often needed for acquiring AT can change performance of people with disabilities. This model, the human activity assistive technology model (HAAT), postulates four components: human, activity, assistive technology, and context. All components must be considered when selecting an AT device. For simple, inexpensive AT, consumers require little if any help in acquiring devices. However, when the AT device is complex, costly, or paid for by a third party, the process of obtaining the device can require the help of individuals trained in providing AT services. The services needed may include evaluations for the types of AT that are needed to enhance physical, sensory, and cognitive functions; improve performance in activities; and increase participation in major life activities. The evaluation may involve an interdisciplinary team of people who have training in engineering, therapy, medicine, and device use. The introduction of AT into the life of a person with a disability requires an analysis of the existing capacities
of the consumer, the settings where the AT will be used, the features included in the AT device, and the goals of the consumer and his or her family, employer, and educator. After the AT device is selected that best fits the consumer's situation, the device is purchased. If the device is inexpensive or the consumer has the necessary funds, the acquisition is relatively straightforward. However, if other organizations provide the funds for the AT purchase (third-party payers), then the consumer may find the process difficult, lengthy, and frustrating. For example, when the AT is paid for by health insurance, the rules for what may be purchased and the forms required for reimbursement are very complex. This part of AT services requires that competent, experienced individuals assist the AT consumer in providing the information required by the reimbursement entity. For AT deemed to be medically necessary, a physician must sign and send in a letter that describes the individual's diagnosis, prognosis, and the functions that will be improved or maintained by the requested device. If the first request for reimbursement is denied, then a lengthy process of appeals ensues. Once a device is acquired, services may be needed to fit, customize, maintain, or repair the AT device. These services are provided at durable medical equipment companies, rehabilitation facilities, or volunteer organizations. An additional important but often neglected service is the training or technical assistance provided to the consumer and his or her family in the use of the AT. For example, communication boards that allow individuals with no or poorly understood speech to make their needs and views known take a significant amount of time to learn. To offer this full array of services, people need to be trained in the wide variety of skills required to match the individual's needs and capabilities with the features of the AT [4, 14, 15].

Future Directions

Advancements in AT will occur in the technology itself, the services associated with the technology, and in the government policies and programs relative to AT. There will more widespread use of universal design, with less special-purpose AT required. People who have disabilities must continue to have access to the Internet to participate in the knowledge-based economy. This is a challenge since the Internet is becoming more and more dependent on multimedia representations involving complex graphics, animation, and audible sources of information; people who have disabilities have greater challenges in the retrieval of information. This creates barriers for those who are blind or deaf. Complicated websites that may include flashing pictures, complicated charts, and large amounts of audio and video data will be difficult for people who have learning disabilities and dyslexia to use. AT needs to take advantage of advances in handheld, portable, and satellite-based communication and computing technologies to allow greater capability for persons with disabilities. Control interfaces that directly sense signals from the brain or nerves need to be further developed to allow greater control of devices by people with severe physical disabilities. Intelligent interfaces are required to adapt to the needs of persons with disabilities to allow greater participation in work, recreation, and self-care. Devices that can transmit messages from the brain to activate target muscles (e.g., finger, arms, feet, legs) without having to pass through the spinal cord need to move from basic research laboratories to clinical trials. Devices based on direct stimulation of the

brain for those with visual and hearing loss need further development. Technology advances will also occur in materials (lighter, stronger, and more durable) used to make devices such as wheelchairs and the cases for portable electronic devices. In the area of service delivery, community centers are needed where people with impairments can try different types of AT without first having to purchase a device. To avoid device abandonment, consumers of AT devices need a greater say in what is recommended for and provided to them and greater control over the resources to purchase AT. In the area of government policy and programs, longitudinal studies are needed to assess the effects of AT interventions on the lives of consumers. Tax reforms are needed to reduce the cost of purchase for the individual and to encourage investment in new AT. Justification for government programs and health insurance purchase of AT needs to expand beyond medical

necessity and in-home use to include activities that are important for community participation by people with impairments, including employment, recreation, education, volunteer services, and many others [4].

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